Menlo Park Notebook #59 [N-80-01-26]

This notebook has no dated entries but was probably used during 1879 and 1880. Most of the entries are by Francis Upton and relate to electric lighting. Included are calculations about the cost of central stations, conductors, and electric power distribution. There are also notes, drawings, and calculations about lamps, dynamos, and vacuum pumps, along with a few calculations by Edison relating to electric power distribution. The label on the front cover is marked "Upton." An index has been pasted onto the inside front cover. The book contains 285 numbered pages.

Blank pages not filmed: 236-241.

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8 per H.P.

Investment

34.

$4.25 per lamp Engine

15

$1.85 per lamp boiler

er lamp per M

gine $4.25 .466

6

8

7

ment

ght

No 59

Index.

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Dist. to calculators see General

LIBRARY OF THE
BOARD OF PATE T CONTRO
120 K.

Alt 8 per H. P.

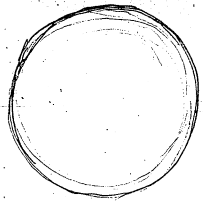
Investment

8/34.
$4.25 per lamp Engine

8/15
$1.85 per lamp boiler

	per lamp	per M
Engine	$4.25	.466
Boiler	$1.85	.20
	$6.10	.666
		.438
Dynamo	$4.00	.547
Conductor	$5.00	$1.651
	$15.10	Investment

If the land is not bought



1 hour each day	Year 365 hours	
2 — —	730	2
3	1095	3
4 — —	1460	4
5 — —	1825	5
6 — —	2190	6
7 — —	2555	7

---

5 hours a day burning 5 cu. ft. an hour

25 cu. feet a day

1825
~~7~~5
91.25 cu. feet a year

9 M a year a burner

1460
5
~~5840~~
7300 7 M a year

five hours a day

9.12) $15.10 ($1.65
912
5980
5472
5080

$1.65 invested per M independant of land 5 hours a day

4 hours a day

7.3) 15.10 (2.07
146
500

$2.07 cts invested per M

Central station 10,000 lamps

2 Engineers	$6.	6
2 Foremen	$10.	10
2 ~~4~~ Wipers & Oilers $1.50	$3.	6
2 Regulators	$4.	4
per day	~~$28~~ $23	26

10,000 lamps 5 hours 5 feet

250 M per day

250) 21.00 (8.4
2000
1000

250) 260 (10.4
250
1000

~~$21 8.4 cts per M~~

$26 10.4 cts labor

Coal under boiler $5.00
~~per~~ 2240 lbs

3 lbs per H. P. per hour

2240) 5,000 (.00223
4480
5200
4480
7200

.00223
3
~~$~~ .00669 per H.P.
.000836 per lamp
200
.167200

16.7 cts per ~~hour~~ M

60 66

Waste & Oil.

Say 1/4 that of coal

~~$1.25~~ 4.17 cts per M

~~Labats~~

Water 1/8 coal
2.08

Attendance	18.4
Coal	16.7
Oil &c	4.17
Water	2.08
	33.3 ~~cts~~ per M

3
running cost ~~31.2~~ cts per M

Depreciation

		per lamps	per M
Engine	3%	.127	.016
Boiler	10%	.18.5	.020
Dynamo	5%	.20	.021
Conductor	2%	.10	.010
		$ .612	

61.2 cts per ~~lamp~~ per year

page 9

9.12) 61.2 (6.7
54 72
6480

6.7 cts per M depreciation

31.3
6.7
38.0 cts running expenses exclusive land and building

Land and Building

60.000

$6.000 a year

365 days

250 M

18350

730

91350) 6000.00 (.065

554100

459000

6.5 cts ~~deprec~~ Rent

31.3 Running expenses

6.7 Depreciation

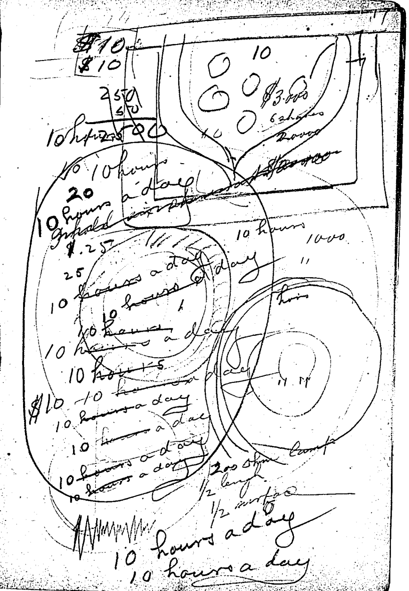
6.5 Rent

44.5 cts per M without

interest 16.5 10%

61.0 cts per M inclusive

The light can then be sold at a price above that to pay for general management and patent rights


$10
$10
10
$3.000
6 shares
20000
250
50
10 hours
20
10 hours a day
$.25
25
10 hours a day
1000
10 hours a day
$10
200 ohm lamp
1/2 length
1/2 surface
10 hours a day
10 hours a day

20 250000
10 P9er H, P

Investment ~~13.02~~ 1.3 =
See page 5 per M

Engine	.362
Boiler	.16
Dynamo	.348
Conductor	.547
	$ 1.417

Labor the same

10.4 per M

Coal	13.36 per M
Waste	3.34
Water	1.67
	28.77 per M

~~50~~
~~20~~
~~1000 share RR. M~~

Depreciation p 15 per M

~~[illegible]~~ Engine	1.2 cts
Boiler	1.6
Dynamo	1.7
Conductor	1.
	5.4 cts

Rent the same
per M 6.5 ct

	28.77
	5.4
	6.5
	40.67
Interest 10%	14.
	54.67 cts per M

Assume Boiler $20 in place of $15

$10 to capital
$1.00 to interest per H.P
$1.00 to depreciation

Investment .27 per M

10 per H.P 2.7 per M in place of 1.6
1.6
1.1 added per M

8 per H.P
3.33
2.00
1.33 Depreciation & interest
2.66 cts per M

44.5
1.33 per M at conversion
~~47.16~~
45.83 per M at conversion

Say $10 for Camp Conductor

$1.00 $1.09 invest per M

5.4 cts per M addition

Interest 8 per H.P. 1. ct per M depreciation

46.83 per M + $10 Boiler

$1's per lamp

47.83 per M

10.8 per M interest Conductor
1.33
13.13
16.5
47.83
77.46 cts per M

$10!
1

$ 20.000 for box
5 000 for – 1/4

700
700
700
700
450

33 50) 5000 (1.5
3350
16500

$1.50 per running foot

Cost of conductors

General Laws.

The cost increases as the square of the distance from the central station.

1 Ohm may be taken as a fair estimate of the resistance of a conductor for 10 lamps.

1/10 of the energy will be lost in the conductor when all ~~[illegible]~~ the lamps are on

~~It~~ If a 200 Ohm lamp can be made in place of a 100 Ohm lamp the cost in a district will be 1/2 for conduc-

If two lamps of 100 ohms each be placed in series and also in multiple are the cost for conductors for both lamps will be 1/2 that for a 100 Ohm lamp or for each lamp 1/4 that of a 100 Ohm lamp

3 lamps placed in the same manner total cost $\frac{1}{3}$ each lamp $\frac{1}{9}$ &c

5 lamps $\frac{1}{5}$ $\frac{1}{25}$

&c &c &c

Jan 26 1880 FRUpton

This for lighting street lamps theatres &c

tors or the distance from the station may be 1.4 times as great so that the station will supply 2 times as many lamps with the same average cost for conductors.

To supply a district with 4 times the area each lamp will require 4 times as much copper in the conductors.

The cost of the box in which to place the conductor may be taken as per running foot

one ~~[illegible] that~~ the same
another

In Table of conductivities, pure copper is assumed [illegible]

The cost per lamp in ~~of~~ a given area is proportional to ~~its area~~ the size of the area

5280
1320

~~700~~
1400

110

10000

102
102
204
1022
10404

Questions

How many feet of gas are consumed in various parts of N. Y. per consumer and an estimate of the average time of burning.

How much horse power is taken and the price paid per horse power up to ~~the [illegible]~~ 10 horse power.

Cost of pipes laid in the street and depreciation

Cost of management

Cost of building lots or rent of same.

Cost of water per H. P

Houses Estimated cost of introducing

Cost of condensing as compared to high pressure engines

Cost of laying pipes or wires in the street.

$\mathcal{E}$ = Energy
L = light
S = Surface

$L = \frac{\mathcal{E}^2}{S}$

c

$\frac{1}{2}$ the surface

Lamps. laws of

Datum

Twice the radiant energy from any surface four times the light from the same surface

The light increases as the square of the energy given off from the same surface

If the surface be halfed keeping the energy the same the light will be doubled There will be four times as much light given offe per unit surface and only one half the number of units of surface.

The light from the same energy is inversely as the surface from which it is given off

---

To keep the light the same and ~~wants~~ yet have it given off from one half the surface will require $\frac{1}{1.4}$ the energy.

1/4 the surface and same light 1/2 the energy

That is since $\frac{1}{2}$ the surface give 2 times the light with the same energy, and as the light varies ~~and~~ as the square of the energy it will take $\sqrt{2} = 1.4$ the energy

---

Keeping the light the same and diminishing the ~~energy~~ surface ~~[illegible]~~ from which it is given, it will require an amount of energy which is as the square root of the ~~energy~~ surface

4

87
1.4
348
87
1218
174

$$\frac{E^2}{R} = \frac{(\cancel{2}E_x)^2}{(2R)}$$

$$R E^2 = E_x^2$$

A 200 Ohm lamp to give off the same light as an 100 Ohm lamp with the same surface will require 1.4 times the E.M.F of a 100 Ohm lamp

That is if a 100 Ohm lamp requires 87 Volts a 200 Ohm lamp will require 121.8 Volts

---

A 400 Ohm lamp will require 2 times the E.M.F or 174 Volts

$\frac{1.4}{1.4}$ $\mathcal{L} = f\frac{1}{S}$ $\left(\frac{S}{2}\right)$

$\frac{\cdot}{2R}$

S $\mathcal{L} = \cancel{4\mathcal{E}^2}$

1.4 $\frac{1}{1.4}$

1461
1.0730
.9270

$\mathcal{L} = f\frac{1}{S}$

$\mathcal{E}rg^2$

$\mathcal{L} = \cancel{f}\ \mathcal{E}rg^2$

$\mathcal{L} = \varphi\frac{\mathcal{E}rg^2}{S}$

$\mathcal{E}rg = \frac{\mathcal{E}^2}{R}$

$\mathcal{L} = \varphi\frac{\mathcal{E}^4}{R^2S}$

$\mathcal{L} = \frac{\mathcal{E}^4}{2R\frac{1}{2}S}$ $\frac{\mathcal{E}^4}{RS}$

$\frac{1}{1.4}$ $\sqrt{1.4}$

9031
1461
1.0492

9398
0730
1.0125

So double the resistance
and half the surface
and still have the same
light will require the
~~same E.M.F.~~ $\frac{1.4}{\sqrt{1.4}}$ the E.m.f.
1.18 the E.M.~~F~~

87 Volts 100 Ohm 1 = surface
101 Volts 200 " 1/2 = "

L 11.2 per H.P.

A loop the same length
and 1/2 the surface ~~will~~
~~gave~~ with 1/2 the material
will give 11.2 per H.P. instead
of 8

Dynamo machine

Laws

The best machine is that which with the least amount of energy consumed on the magnets will give the greatest E. M. F on the smallest resistance in the armature so long as the spark on the commutator may be kept under. Interest on investment, friction and magnetic friction being made as small as possible

The unavoidable losses are as follows

Magnet — **Energy**

Friction on bearings.

Magnetic retardation.

Local action

Spark on commutator.

Friction on commutator

~~Deprec~~

Money

Depreciation

Commutator

Brushes

Belt

Bearings

Covering wires

The ~~running~~ ~~loss~~ cost of the magnets is ~~to have~~ when ~~the~~ the interest on the amount invested in ~~them~~ equal to the cost of the energy consumed in them.

The friction of the bearings must be made as small as possible

---

Magnetic retardation may be largely avoided by using very soft iron

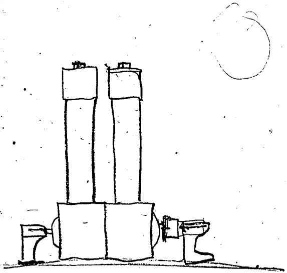
Local action is in ~~the~~ the Edison machine of no consequence

$\frac{1}{50}$

$\frac{1}{50}$

Ean

Spark on the commutator may be made very small by ~~[illegible]~~ placing the brushes endways and widening the commutator



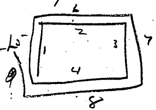
In winding the machine
Twice the speed 1/4 the
resistance

If the armature be made twice as long as now and have two magnets placed over it. One layer of wire will then do the work The present machine may be taken as having ~~3/4~~ 16 Ohm resistance

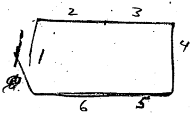
The wire on the new machine would be 3/4 as long

~~[illegible]~~

Present



new



6/8 = 3/4 about

1/2 the resistance per foot

3/4 X 1/2 = 3/8 the resistance

2.25) 22000 (9.8 00 can be lost on
2020
1800
9.800

$3/8 \times .16 =$ .06 Ohm resistance

$1\frac{1}{2}$ times the radiating surface as that ~~In fact~~ $\frac{1}{2}$ the heat ms ~~times the heat~~

$1\frac{1}{2}$ times the heat may be given off from the machine

$$(X\cancel{C})^2 \times .06\cancel{R} = 1\frac{1}{2}\cancel{C}^2 \times .16$$

$$X^2 = 1\frac{1}{2} \times \frac{8}{3} = 8$$

$$X = \sqrt{8} = 2.8$$

2.8 times the lamps

$50 \times 2.8 = 140$ lamps

Say square wire

.042
3
126
.026
.152

.013
2
.026

042
4
168
026
.194
.152
388
970
194

Cross section .029488

3.14
.042
628
1256
.13188
.042
26376
52752
4).0055389 6
.00113474

.001134
12
2268
1134
.013608

136)294(2 1
272
220

$\frac{3}{4}$
1-

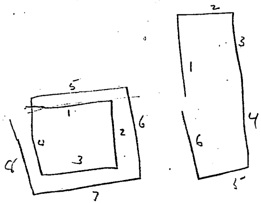
2.1 times the resistance
in round .042 than in
square

.03 Ohm in machine

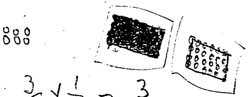
03) 1000 (333

333 Lamps each
100 Ohms and still
10 to 1 exterior to internal.

6) 1000 (166



3/4 the total wire



$\frac{3}{4} \times \frac{1}{4} = \frac{3}{16}$

20 inches diameter

2 times the present bore

2 times the surface

One layer sufficient as it will be twice as ~~strong~~ the surface
2 times

2 times the length of wire on ends ~~1½ times~~ the total wire

Each division 2 times as wide and twice as thick 1/4 the resistance

$3/4 \times \frac{1}{4} = \frac{3}{16}$ the resistance

E.M.F. since the magnets are much stronger and the armature magnet must stronger Same speed of wire should give double the E.M.F.

That is half the speed of pulley

.03 Ohms

1.28
6
7.68

36
1.2
72
36
43.2

300 3 .12 hours

80

48 feet

100 1500 66

M

$3/86 \times .\cancel{4}6 = \cancel{.06}$ Ohm
$.03$

.03 Ohms

2 times the mass of metal in magnets

1.~~4~~ times the diameter

$m = \pi L\, R^2$

$2M = \pi L R^2$

$\cancel{2} = 1.2\, R^2$

$R^2 = \frac{2}{1.2}$

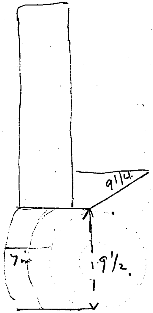
$1.2)2(1.66$
$\underline{12}$
8

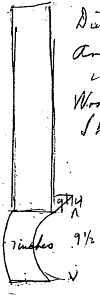
$R = 1.28$

$\underline{0.2201}$
$.0101$

Make magnet 7¾ inches diam

" " 3 feet 7 inches long




9 1/4
7 inches
9 1/2

Diameter bore	9.75
Armature overal	9.67
" over iron	9.19
Wooden core	6.25
Shaft	1.625

9 1/4 diam

$$\begin{array}{r} 9.19 \\ 6.25 \\ \hline 2.94 \end{array}$$

19.5
3.14

1.12900
.4969
1.7869
.8751
$\bar{1}$.9118

.61.2

.816

042
.013
.055
6
.385
~~6~~

2 | .816
.408
.385
.023

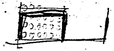
.02

||

023

.385
4
0

0



19

3.1.4
2

.042
.021
.021
.21
42
.000441

4
24

$\bar{4}$.6444
0.4969
3.14
$\bar{3}$.2413
1.3802
~~2~~.6215

.00174

24

.0418 Total Cu

.385 One division ~~of~~ or
1/150 of circumference

~~#~~

$\frac{.385}{51}$ = .075
.013
.062

~~053~~
~~4~~
~~212~~

.062
4
.248

.0250

.000625

~~2.3979~~
~~2.3979~~
~~4.7958~~
~~.4969~~
~~3.2927~~
~~1.1761~~
~~2.4688~~

~~.001918~~
~~.15~~
~~.9294~~

Gas made from kerosene costs .66 cts. per M for material at kerosene 9 cts. a gallon as now

This is from actual practice

Apparatus for 30 lights 4½ feet cost about $300.

Water power in quantities available

---

9 M per year per burner

10000 lights from one station

	Homing	Allowance
Belts	7.000	4666
Shafting	5.500	3867
Iron Structure	8.000	7000
Wood flooring &c	3.700	3000
5 Engines	42.500	✓ 42.500
Engine foundn	2.300	✓ 2.300
Boilers	20 000	✓ 20,000
Faradic Machines	36.000	24.000
	$ 125,000	$ 107,333
Conductors $5.00 per lamp		50,000
		155,333

$$90000\,)\,155{,}333\,(\quad 1.725$$

$1.725 per M capital

10

Depreciation

Belts	10%	$. 466.60
Shafts &c	2%	77.34
Iron Structure	2%	140.00
Wood flooring	10%	300.
Engine	3%	1275.00
Foundation	1%	23.
Boilers	10%	2000.
Farada Machine	3%	720
Total	5%	$ 5.001.94
Indicator	2%	1000
		$ 6.001.94

90000

Depreciation 6.6 cts. per M

Expenses

Labor

2 Engineers	6
2 Foremen	10
2 Wipers & Oilers	3
2 Regulators	3
Per day	$ 22
Per M	8.8 cts

~~Dust~~ Coal under boiler, include Labor $3.50 per 2240 lbs

$ 25.85 per day

10.3 per M

Water

Waste oil &c 1/3 Coal

3.76 cts per M

Rent $10,000

11.1 cts. per M

Executive $11 per day
4.4 per M

Depreciation	6.6
Labor	8.8
Coal	10.3
Water &c	3.76
Rent	11.1
	40.56 cts
[illegible]	4.4
	44.06

10000
5
50000

Delivered to Consumer

Spend $5.00 more on conductors, and save in Investment.

5% Engine
Boilers
Dynamo
Belts
Shafts &c same

Total plant 5% $ 5.265.

Depreciation	5%.	.30
Labor	0.	
Coal &c	2%	.2 .075
Rent	0	
Executive	0	

---

per M annually .575

Total capitalized
5.230
5.260
10.490

$10,500 can be spent
to save 5%

$2,100 to save 1%

(10,000) 2,100 — 20 cts a burner
to save 1%

1,00 a burner to save
5%

1250
16 per H.P
7500
1250
$20,000

---

2 Stokers $6 per day

Dividend

50 cts per M	3%
60 cts per M.	9%
75 cts per M	17%
90 " " "	26%
$1.00 " -	32%

If 600 Horse power can be sold during the day for 10 hours.

The ~~Rent~~ Amount invested the depreciation the labor and the rent would not need to be counted as they have been estimated on a basis of 15 hours a day wear.

The cost of coal and oil and waste are alone to be taken account of

---

Estimate of the cost of lighting 10,000 burners from a central station

It is assumed that a burner will consume the equivalent of 5 cu. ft. of gas an hour in giving ~~is candles~~ a light equal to that from 15 candles and burns on an average five hours each day. Tests show that eight such lights may be obtained from an indicated horse power in the belt

To furnish such lights 1250 horse power are required in one station

~~Five hours a day = 25~~

A burner which is lighted 5 hours a day consumes 25. feet a day or about 9.000 cu. ft. a year

For convenience designate 1000 Cu. ft. 1 M.

10,000 burners in a year will consume 90,000 M

Investment

Boilers & Chimney	20.000
5 Engines	42.500
Foundations	2.300
Iron Structure	7.000
Shafts &c	3.900
Belts	4.700
Wood flooring	3.000
Faradic Machines	24.000
	107.400
Conductors	50
Total	157.400
per M	$1.75

Depreciation

Boiler	10%	2.000
Engines	3%	1.275
Foundation	1%	23
Iron Structure	2%	140
Shafts &c	2%	77
Belts	10%	466
Wood flooring	10%	300
Faradic Machines	3%	720
		5.001
Conductors	2%	1.000
		6.001
per M		6.6 cts

2240

845
35
4225
2535
29575

1250
15
6250
1250
2240) 18750 (8.45
17920
8300
~~8960~~
12400

8.37
3.5
41.85
2517
29.39

630
672
1580

Expenses:

Labor (Stoking included in coal)

2 Engineers	6
2 Foreman	10
2 Wipers	3
2 Regulators	3
	$ 22

per M ~~[illegible]~~ 8.8 cts

Coal. Dust coal is taken at $3.50 a ton under the boiler so as to include wages of stokers. 3 lbs of coal an hour is required to ~~[illegible]~~ give a horse power

8.4 tons $29.39 ~~$[illegible]5~~ per day

11.756
~~10.3~~ cts per M

Water &c 1/3 coal
~~3.43~~ cts per M
3.91

Rent $10,000 a year
11.1 ct per M

Executive
1/2 labor $11 a day
4.4

Summary per M

Depreciation	6.6 cents
Labor	8.8
Coal	10.3
Water &c	3.8
Rent	11.1
Executive	4.4
	45.0 cts

It costs 45 cents per 1000 feet delivered to the consumer for Electricity.

Dividends

Sold at 50 cts per M	3%
60 " "	9%
75 " "	16%
90 "	25%
$1.00 " "	31%

If for 10 hours during the day 400 horse power could be delivered at the consumers at a cost of 600 at the station and with an investment of $12.500 for additional conductors, at 50 cts per M a dividend of 17% could be earned.

In making this estimate it was remembered that the wages, depreciation were calculated as fully paid by the light for a day of

15 hours. This leaves for cost of power only the coal and water &c consumed.

---

200 H. P sold at 50 cts per M
200 " " " " 60 " " —
10000 Lights 60 —
Dividend 25 %

---

200 H. P. sold at 50 cts per M
200 " " " 75 " —
Light 75 " —
Dividend 40. %

---

200 H. P. sold at 50 cts per M.
100 " — — " 75 " —
100 " . 90 " —
Light 90 —
Dividend 49 %

---

200 H. P. sold at 50 cts per M
100 " — " 75 " —
100 " " . $1.00 —
Light — . $1.00 —
Dividend 56 %

It should be considered that the light is far better than gas, and can be sold at a higher price than gas and pay profits.

For example.

In New York today

Preliminary Estimate of the cost of lighting 10,000 ~~of~~ Electric burners from a central station, ~~each burner~~ giving a light ~~of~~ equal to that from sixteen candles, or taking the place of a gas jet consuming 5 cu. feet an hour.

Five hours use of each burner is assumed as the average for the year. In taking this figure it was remembered that during the day a large number of lights are used in dark rooms and during the night a still larger number are used ~~through the whole night.~~ from ~~8 to~~ eight to twelve hours

A gas jet which consumes 5 cu. feet an hour burning for five hours each day will consume 25 cu. ft. in that time, or about 9.000 cu. feet in a year.

For convenience in making comparison with gas ~~designate~~ the electrical equivalent, that is ~~or~~ the amount of electricity which will produce the same ~~amount of~~ light as ~~four~~ ~~gas~~ 1000 cu feet of gas, is here designated as M. For example an electric burner is said to consume 9 M a year, or 10,000 burners 90,000 M a year.

Tests show that it is possible to obtain 8 lights from one horse power carried by the belt, so that for 10,000 light 1250 horse power will be required

1 Investment

Boilers & Chimney From Babcock & Wilcox estimates	21.000
5 Engines Holly's estimate	42.500
Foundations	2.300
Iron Structure	7.000
Shafts pulleys &c	3.900
Belts	4.700
Wood flooring &c	3.000
Water heater & pumps	7.000
Iron floor and supports Boiler	6.000
Faradic Machines	24000
Conductors	50000
	171400

Total investment per M $1.90

Treasury 20,000 shares

100,000 shares
80 000
24,000 shares

$\frac{24}{100}$

8000 shares

30,000 shares to owners

50000
20000 to treasury

30000

~~6775~~
~~78~~
~~00~~
~~60 25 0~~
~~61 2~~
~~6~~

~~1078~~

62500
24000
38500

10000	Edison	~~5000~~
10000	~~[illegible]~~	~~5000~~
10000	~~[illegible]~~	~~5000~~
4500	~~[illegible]~~	~~3600~~
1875	Lopem	~~475~~
875	~~[illegible]~~	~~675~~
750	~~[illegible]~~	~~500~~
250	~~[illegible]~~	~~30000~~
250		~~30 340~~

38500) 3000000 (.78
269500
305000
308000

~~.78~~
~~45~~
~~390~~
~~312 0~~
~~351~~
~~1875~~
~~78~~
~~14000~~
~~13 20~~
~~1452~~

~~7800~~
~~7800~~
~~7800~~
~~3510~~
~~1452~~
~~672~~

385) 300.0 (7
15

2.4771
2.5855
$\bar{1}$.8916

.779

[redacted]	7785	7791
[redacted]	7785	7791
[redacted]	7785	7791
[redacted]	3507	3508
[redacted]	1460	1460
[redacted]	681	682
[redacted]	584	585
[redacted]	195	196
[redacted]	195	196
	29977	~~29998~~ 30000

29977 instead of 30000

23

4500
3.6532
$\bar{1}$.8916
3.5448

1875
3.2729
$\bar{1}$.8916
3.1645

875
2.9420
$\bar{1}$.8916
2.8336

750
2.8751
$\bar{1}$.8916
2.7667

250
2.3979
$\bar{1}$.8916
2.2895

300
385

4771
5855
1.8916

250
250
125
50
62500

83.3 Volts

220
220
44
44
484

73.3

62:48

48:62!!

73.3
73.3
2199
2199
5131
537289
44.
21488
2148.8
2363.68

2364 ft. lbs.

3031 ft. lbs

2364)33000(14
2364
9360
9456

83.
83.
249
664
6889
44
27556
27556
303116

70
70
4900
4.
19600
196
2256.00)33000(14.6
22556
10440
9024
14160

205
68.3
68.3
2049
5464
4098
4664.89
44.
18656
18656
2052.16)33000(15.1 per H.P
2052
12480
12236
2360

Depreciation &c

Boilers & Chimney	10%	$ 2.100
Engines	3%	$ 1275
Foundation	1%	23
Iron Structure	2%	140
Shafts pulley &c	2%	77.
Belts	10%	470
Wood flooring &c	5%	150
Water heater, pumps	5%	350
Boiler floor	2%	120
Faradic Machines	3%	720
Conductor	2%	1000
		$ 6.425

Depreciation M annually
7.14 cts

Taxes 2% 3.8 cts per M

3 lbs an hour
15 lbs a day

It is recommended that a small amount be charged yearly for each burner, enough to pay for breakage and attention.

2240 lbs to a ton. 3.50

```
      5441
    3.3502
    3.1939   $.00156
15   1.1761
1250 3.0969
    1.4669
```

$29.30 a day for coal
4
$117.20

Expenses

Labor (Stoking included under coal)

Per day	2 Engineers	$ 6.
	2 Foremen	10
	2 Wipers	3
	2 Regulators	3
		$ 22

Executive may be taken as about 1/2 of this or $11
∴ $33 per day
or 13.2 cts per M. Total

Coal
Dust coal is taken as costing $3.50 a ton under the boilers that is including labor of stoking.
3 lbs of coal an hour are required ~~for~~ one horse power.

$29.30 for coal a day
11.7 cts per M

9000/10000
1.1.1

Water for boilers waste oil &c Estimated as costing 1/3 of coal 3.9 cts per M

Rent $10.000 a year for the cellar and first floor of a building 100 X 50 feet in any locality near the place where required

11.1 cts per M

Summary

Depreciation	7.14
Labor	13.2
Coal	11.7
Water	3.9
Rent	11.1
	47.0 cts per M

That is the cost of the light delivered to the consumer will be 47. cts per M

		47.0
Taxes	8%	3.8
Insurance	1/4%	.48
		51.3 cts

3
190

.4771
2.2788
2 1.983

13
190

1.1139
2 2788
2.8351

28
190

1.4472
2.2788
$\bar{1}$.1684

43
190

6335
2758
$\bar{1}$.3547

58
190

1.7634
2.2788
$\bar{1}$.4846

1.25
.47
.98

1.8921
2.2788
.6133

~~2.0969~~
~~2.2788~~
.8181

2.1761
2.2788
.8973

150
44
103
2.0123
2.2788
.7335

Selling light alone

The dividends will be

at	50 cts per M	1.5 %
"	60 " " "	6.8 %
"	75 " " "	14.7
"	90 " " "	22.6
"	$1.00 " "	30.5
"	$1.25 " "	41 %
"	$1.50 " "	54 %

204) 280 (13.7
204
190
760
612
1480
204) 107 (52
1020
300

600 H.P. 50 cts

a 1 H.P. delivered
1½ H.P. in station

1.5 X 8 X .5 = 60 feet an hour

$\frac{1000}{60}$ = 16.6 hours per M

16.6
5 cts for 60

16.6
5
83.0

Power estimate.

It is estimated that 400 horse power can be sold during the day for various purposes, Small shops, elevators, lathes, sewing machines, pumping.

10 hours average use of this amount is assumed. The cost will be simply the cost of coal under the boiler and water &c. $12500 will have to be invested in conductors additional. ~~[illegible]~~

Power is sold today in New York at $150 a year or 5 cts. an hour or at the rate of 8.3 cts per M. Electric power has this advantage it does not cost when not used

2% 12,500
.02
250.00
)125.00
.27

125.00
13.9 cts to invest
per M

---

1 H.P. sold
cost 1.5
~~4~~5 lbs coal
.64
.00156
9
.01404

12500
00156
.64
624
936
.0998
1.4 cts
.43
1.83
.27
2.00
91
27
1.18
~~1.00~~ ct

50 cts per M
1/20 = .05 ct per foot

60
.05
3.00 cts an hour
1.18 profit
1.82 1 cts
16.6 cts
lit on H.P
per M
1.16

at 50 cts a M light & power
Additional dividend Total
11 % 12 %

at 60 cts M light & power
14 % 20 %

at 75 cts a M light & power
19 % 34 %

at 90 cts for light and 200 H.P.
75 cts for 200 H.P
22 45

at $1.00 for lights and 200 H.P
75 cts. for 200 H.P
24% 54%

at $1.25 for lights and 200 H.P.
75 cts 200 H.P
28 % 69%
4

Additional Total

At $1.25 for lights and 200 H.P

1.00 200 H.P

33 % 73 %

at $1.50 for lights and 200 H.P

$1.00 200 H.P

38 % 92 %

204) 4537.0 (26

4066

1220

26

26

33

59

Ven

24 hours a day

Depreciation	12 cts per M
Expenses	20 ~~cts~~ " M
Coal	15 cts M
Water	5
Rent	22
	74 cts per M

$3.80 per M

five hours a day power

10 3.80) 26.0 (8.

380) 26.00 (7 %

~~2 40~~

2 60

$1.00 a thousand 7 %

Power 400 H.P a day

2240) 3500 (.156
2240
12600
~~1 440~~
1 1200
14000

.156 ~~cts~~ per lb of coal

156
9 lbs 3 H. P.
1.404 ct 1
.702 per 1½ H. P.
.23 water
cts .93 Per H. P

1.18

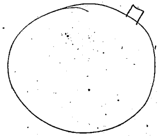
156
3
468
156
.624
~~31.200~~ per M

40 feet
= 1/25 M

.624
15.6

after depreciation

Cost per M 15.6 cts per M



3

Estimate

Taxes	2%
Insurance	1/4 %
Patent right	1/3 capital

125 000
3
100:000

11.7
3.9
15.6

Taxes 1.90
.02
.0380

additional for patent right
1.90
.63
$2.53 per M

126

Suppose a station for lighting street lamps average use 10 hours a day

10 lamps in series 10 per H. P.

10000 lamps

1000 H.P.

night service alone

Rent $5.000 a year

Coal $3.00 under boiler

~~H.P.~~ 2 lbs. per H.P.

Engine $65 a H.P.

Boilers 1/3 less than in other estimate

1/2 for patent

$21 invested

127

Engines $65.000

Boilers for 1250 H.P cost $20000
1000 will [illegible] $16000

	5333
Boilers	$ 9.667
Shafts	3867
Belts	4666
Iron Structure	7000
Wood flooring &c	3000
Engine Foundation	3000
Faradic machines	24000
Conductors	20.000
	65533
Boilers	9.667
Engines	65.000
	140.200
Lamps 25	2.500
	142.700

$14 per lamp invested

Cost of running

Labor $14 a day

365
14
1460
365
$5110 a year

Coal 2 lbs. an hour

1120 H.P. an hour

Say Ton of coal to run engine an hour

10 tons a day

3650 ton a year
3.5
18250
10950
$1.27750 Coal

2.129 Water &c

Russia

Austria

Germ 250
300
300 Fran 75000
300
00

Belg 240
300

Spa 72000

Italy

237
3000
718

210
300
3000

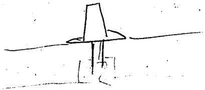
233½
3
99

230
3
690

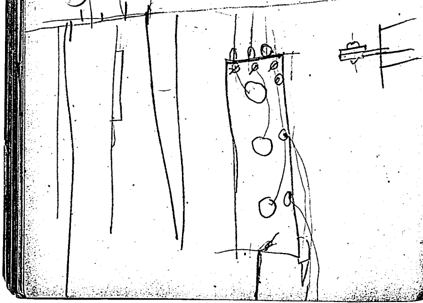
232
3
696

0 3

.33

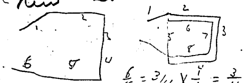


100
100
10000
44.3
443000
3
33) 1,329,000
44.3 H,P ~~to~~ 20 to 1



Edison

New 20 inch



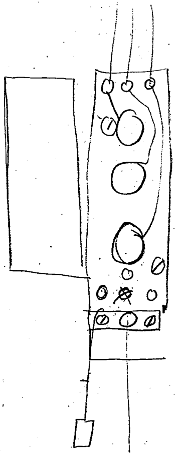
$\frac{6}{8} = 3/4 \times \frac{1}{4} = \frac{3}{16}$

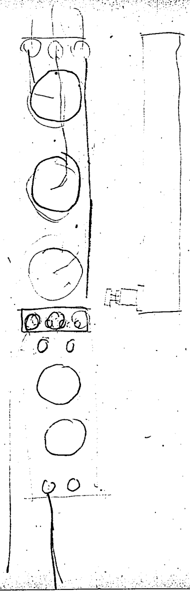
$\frac{3}{16}$ of the resistance of the 10 inch

2 times the surface

$X^2 \times \frac{3}{16} = 2$

$X^2 = \frac{2 \times 16}{3} = \frac{32}{3} = 10.66$





E

3/16 the resistance
2 times the surface

$(xc)^2 \, 3/16 = c^2$

$x^2 = \frac{16}{3} = 5.33$

$x = 2.3$

$5.33 \,(\, 23$
4
.4 3) 1 33
1 29
4

23
23
69
46
529

$$\begin{array}{r} 2.3 \\ 1.4 \\ \hline 92 \\ 23 \\ \hline 3.22 \\ 50 \\ \hline 161.00 \end{array}$$ Lights

161 Lights same heat
per unit surface

150) 100.0 (.666
900

.03) 66
22

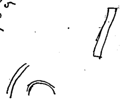
150 light 22 to 1

1½

·005

.005
3
.015

1.5
.015
75
15
.0225



3/16

·20 ·20

$\frac{2}{10}$ $\frac{1}{5}$

$\frac{22}{1000} = \frac{11}{500} = \frac{1}{45}$

$\frac{1}{1.4}$ 3000

√2 1.4

1.4)3000(2150
28
20
14
70

3000 ft. lbs to give 16 candles

1000 ft. lbs

1500
21

$\frac{1}{4}$

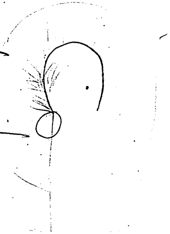
200

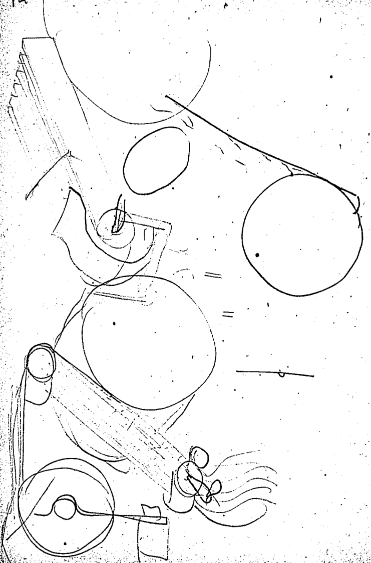
1 inch

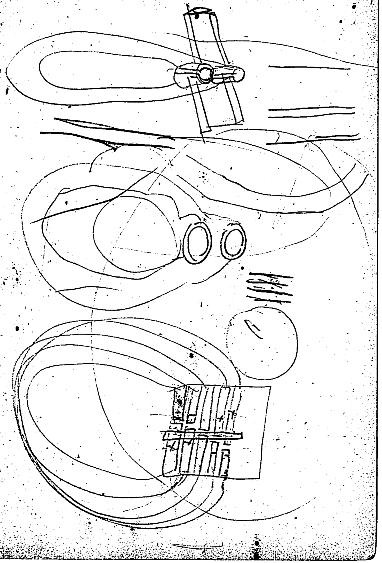
.5

½

150
3
450
2
3~~4~~)900
~~30~~
36







20 light per H.P.

A Dynamo machine giving ~~60~~ 90 Volts Em.F. with 75 coils of two ~~layer~~ each.

$\frac{90}{75 \times 2}$ = E.M.F on one wire laid across face

150 | 90.0 (.6 Volt
 900

50) .10 (.012
 .012
 .000144
 443
 432
 576
 576
 .0063792

.0063 On Ohm

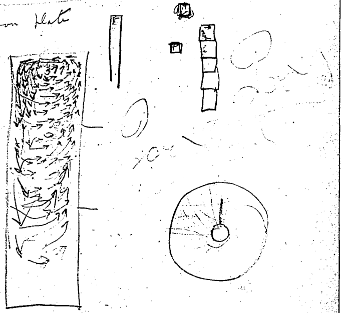
$\frac{1}{1000}$ ohm

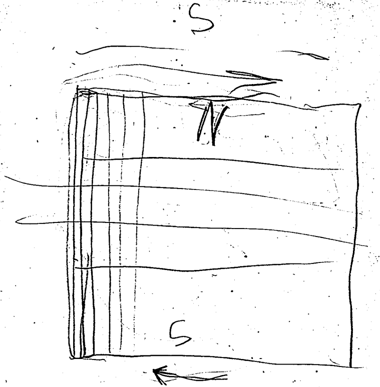
6.3 ft. lbs $\frac{1}{1000}$

63. ft. lbs $\frac{1}{10000}$ Ohm

63~~0~~ ~~ft. lbs.~~ $\frac{1}{100000}$ Ohm

Iron plate

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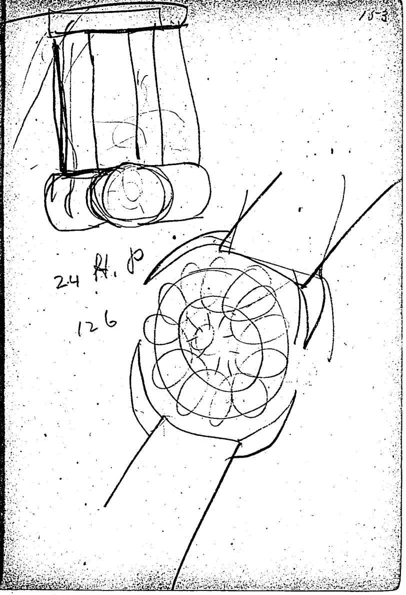
S


2.4 ft. ρ
126

4 Machines

$\frac{1}{8}$ H. Power

On 100 Ohms

Make magnets four
total resistance
25 Ohms

On each machine
make $\frac{25}{4} = 6.25$ Ohms

Present machine
1.7 Ohms on magnet

1/4 area

$$\begin{array}{r} 1.7 \\ 4 \\ \hline 6.8 \end{array}$$

Wind magnets with six layers
of wire 1/2 the cross
section of present magnets

Estimate

~~Or~~ The present .14 Ohm machine with plates heats more running without any ~~lights~~ current being taken from it than the round small wire .56 Ohm does giving 20 lights. It is reasonable to suppose that that is equivalent to 40 lights taken from the .14 Ohm machine. The machine should run 70 lights with safety ~~by~~ but heats with 30 lights badly

~ Cost of machine
$200

Since by doing away with the heating $\frac{4}{3}$ more lights can be obtained

$\frac{4}{3} \times 200 = \$266$

. $266 can be spent on the armature to save ~~that~~ the heating

~ Since the energy lost is .4 of a horse power
1 ct an hour
~~10~~ 4 cts a day 10 hours

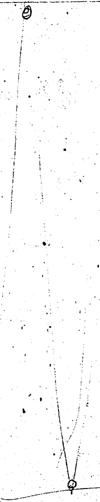
$$\begin{array}{r} 365 \\ .04 \\ \hline \$14.60 \end{array}$$ cost for horse power

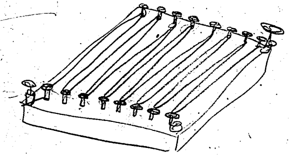
$146 capitalized

$$\begin{array}{r} .146 \\ 266 \\ \hline \$412 \end{array}$$ can be spent on armature

Krarerie estimate
$25 as the additional
cost of small iron
square wire.

Forqueral
Mining
Forche Gracke
New Idria
Mining
Idria
Mining Co.





1st measurements

off pump 242

2186 $\frac{1}{3}$ foot lbs

R. Cold 234.

Corrected for 10 ohm R German S – 2056.

Upton made error in measuring resistance

new measurement

More than a gas jet.

2359 foot lbs
2359

fourteen per horsepower

2nd Lamp gas jet 21 $\frac{1}{2}$ per hp.

R of pump 380 after burning 2 hours 390,

2186.
130
2056.

Gordon

90
90
8100
44
32400
32400
356400

Balbo
Balboa
b
Balboa
Balboo
Balboa

163) 2186 (1.3
163
556.
2 2 489.
67.

Centenarian

163) 356400. (2~~7~~86 $\frac{1}{3}$
326
304.
163
1410
1304
1060
978
82
246

2180
15
10900
2180
32700

3

1520
20
30400

1520
22
3040
3040
33440

134) 356400 (2659
268
887
804
800
670
1300
1206

Portland, Portland Portland

20

134) 2659 (19
134
1319
1206
113

2659
200
2359

2359
14
9436
2359
33026

220) 1620 (7 1/3
1540
80
3
240

220) 356400 | 1620
220
1364
1320
440
440
00

15
7
105
5

1620
110
1520

225

55 Ohms
21.3
34.3 Ohms Lamp

No 683

---

75 Ohms

225 : 165 :: 75
75
825
1155
225) 12375 (55
1125
1125
1125

91.66

55 : 34.3 :: 91.66
343
27498
36664
27498
55) 31439. (57.1
275
393
385
89

34.3) 1439300 (4196
~~1029~~
1372
673
~~686~~
343
3300
3087
2130
4196) 33000 (7.8
29372
36280

No 696

150 Baste fibre

150 : 165 :: 75
75
825
1155
150) 12375 (82 Ohms
1200
375

82) 372000 (4536
328
440
410
300
246
540

4536) 33000 (7.3
31752
12480

No. 695 Twisted fibres

263
87
87

130 : 165 :: 75

130) 12375 (95
1170
675

95 Ohms

95) 372000 (3915
~~33000~~
285
870
855
150
95
550

3915) 33000 (8,5 per H. P.
31320
16800

No. 696

135 Lamps

150 Resistance

135 : 150 :: 75 :

150

350

75

135) 1100 (81 Ohms

~~945~~

1080

200

24.5

24 576

30

900

No. 700

215 75 Ohms

180 Lamps

180 : 215 :: 75 :

.75

1075

1505

180) 16125 (89.5

1440

1725

1620

1050

Lime

Soda = 0

11° 30′ R = Lead

7° L Lithium

5° 15′ } Green line

2cent 8° } Unknown

10° 3/4 R Strontia

7 : 11 : 361
11
361
361
7 | 3971
567

11.5 R Lead

---

7 L Lithium

11 L Strontia

D lines 1002.5 mm
1006.5 mm

Lithium 644.5
Strontium 361.5

L

100 2
893
107

7 : 10.9 :: 107
10.9
963
107
7) 1163
166.6
1002
1168

~~23~~ 27.5

1005
645
365

[illegible]
32

50

31

18

7 : 10.9 :: 1~~9~~8 : 28
18
872
109
7) 1962
.28

109° Between Lithium and Na
365 Bisut other – – Na

~~109~~
365 : 109 :: 18 :
18
872
109
1962

365) 1962 (5.3
1825
1370

4.25 4.25
19.25

110 : 365 :: 4.25
4.25
1825
736
1460
110) 155.125 (14
110
45

~~4.25~~

7 : 10.9 :: 110
110
1090
109
7) 1199.
171

1005
171
1176

6 8
5 18
50'

1750 . Li
1000 Na
750

10.9 : 5.25 :: 750 :
750
26250
3675
109) 39375 0 (361
327
667
654
130

1361 60) 364
4 6 8
04
6 04

6 8
1 44
4° 24

~~5° 30'~~

8° 28' R Lithium
6 8 L Sodium
2 20
1° 20' R Strontium

8
60
480
28
468
368
100

6
60
360
8
368
80
448

60
80

1° 44' L Pt points in vacuum
5° 18' L " "
6° 12' Sodium

100:448::19
19
4032
448
8512

360

100:264::360
360
15840
792
95040

1005
950
1955

19:56::360
56
2160
180
19|20160
19
116
114
20

1061
1005
2066

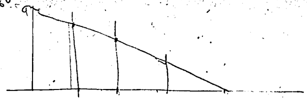
1005
644
361

100:448::361
361
448
2688
1344
1617.28
1005
2622

1044
60
104

368
104
264

100:264::19:50
19
2376
264
5016



25c

200
~~200~~
44
40000
1760000

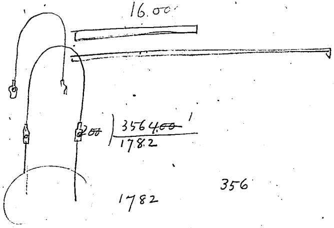
252
252
504
1260
504
63504
44
254016
254016
2794176

5 . 2/4

25

2½. 200, 8.

16.00



~~200~~) 356400 / 1782

356

1782

1600. (

356400
8
16~~00~~) 28512~~00~~ (178
16
125
112
137
128
32

2851200

200
200
40000 . 4

400
400
160000
44
640000
640000
640000
7040000

800

0

3200

253
253
759
1265
506
64009
44
256036
256036
3200) 2816.37~~9~~6
256
256
2254
22
323
288

889
4
3) 576

2
90
90
8100
44
32400
32400
~~200~~) 35640~~00~~

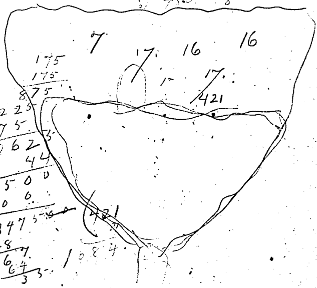
R

7290

1780 3600 : 16
1500

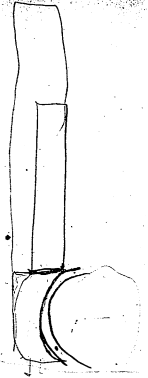
2
4

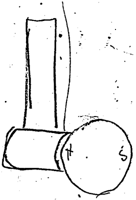
8



175
175
875
1225
175
30625
44
122500
122500
~~32~~) 1347~~500~~
128
67
64
33 : 1384

1005
645
360





18.

105
50
55

Lithium 4° 25' R
Na. 2° 9' R
L. 4° 22' R

Sr. 5° 6'.5 L

4° 25
2° 9
2° 16
120
136

2° 9'
5° 6.5
7° 15.5
60
420
15
435

Sl 10' L

2°9
120
129'
10'
139''

1° 59
60
119' m

139 : 435 :: 77

77

30.45

3045

139)33495 (~~0~~8

238

969

139)334

1° 5′ L.

1505 : 2726

505 : 1726 :: 139

139

15534

5178

1726

505)239914 (4⓪3.7

in place 435

220

1990

1535

3650

31

1° 44′ L was aras one line

Na 6° 8

1 44

4 22

2 40

2 62

2020

5° 18
00
300
18
318

6 8
5.18
50

Clamps

A 2° 6' L5 || Two lines Rt

4° 58' L2

1° 23 R

||| A | B

L_B 1° 52' | 3

3° 33' | 3

3° 41.5 | 3

3° 44.5 | 2

4° 56 | 3

5° 2 | 4

6° 55' L

~~Na 2° 18'~~
2° 9 R Na

4° 6' R

3° 5'

2 18 || Two lines

2° 9
2° 6'
4 15
60
240
15
255

5° 2
2 6
7 8
60
420 428

Lamp 727
Fibre held in paper clamps

R = 169 Ohms cold
= 83.5 hot

2381 ft. lbs
14- per. H. P
Gas jet

2° 43'.5 R. Na lines
2° 42'

2 42
5 17
7 59

5° 17' L Sr.

Na 07° 31 Na L line
Sr 7° 33 ~~R~~ ~~Lr~~ Strontium
Sr 35 R

Lr ~~3° 20~~ L 3° 20 ? ~~Lithium~~ ?
2° 18'
~~[illegible]~~
Lithium

7
60
426
33
455

180
20
200

Lithium 2° 18'

138

O Rubium

Lead impure Edison

Na = 0

120
24
144 2° 24' R Ultra Red

65 1° 5' L Exceeding bright 10 Nebulous.
Huggins 1240

81 1° 21' Very bright .7
Huggins 1279
Great groups of lines

2° 8' Like last
128 Huggins 1479

4° 2'
242

4° 18.5' Middle between two lines shade wider than D lines
255
Huggins 1960.5 1965 10
Nitrogen

7° 16'½
60
7
420
16.5
436.5

9 56' Very bright [illegible]

540
36
576 3329 None

10° 49'

Tin impure

Sodium nearly O

13' R Another line at side ~~and~~ nearly as bright more nebulous looks like sodium lines enlarged
988.5
1000.5
Tin

1° 42' R Strong line
102 648 Sn

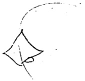
2° 0.5' L Very bright
Huggins 1076 Sn

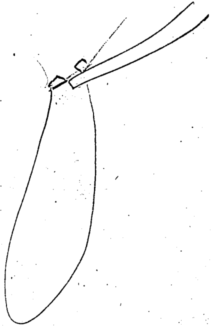
1145 47 Very bright

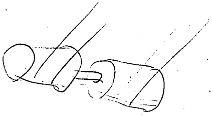
1° Very thin bright line
1219

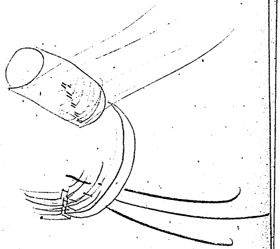
1° 16' Strong nebulous
1260

1° 18' Twin with last
1284









120
22.5
142.5 2° 22'.5 Bright nebulas line
1524 Sn

4° 21' Centre Two lines
261 1966.5-10 like D lines
N 1967

7° 19'.5 little bright than
439.5 a great many lines
N 2669 in vicinity

8° 23' Thin bright line
480
23
503 2777 standing alone

9° 14'
540
14
554

Raynor "Rt."

$1\overset{7}{2}'$ R nebulous Bright

55'.5 R Big nebulous spread
No 805.2 n. out line.

1° 44'.5 R Thin red line
60
104
1° 59 Nebulous red
~~5655 Nitrogen~~ Thin red

2° 4'.5 Thin " "
124
5655.5 Nitrogen

10' L Centre Two thin
1044.5 S lines exactly as D lines
1045.5 S not bright
Pt

~~10' L~~

39'.5 L Thin bright line
n 1118'
46'.5 Thick " "
52' Thin bright line
2° 33' Thin sharp bright line
155
2° 4'
3° 15' Thick band not very bright
195
4° 26' Centre Bright double lines
0 1678^{5}
0 1699^{5}
7° 19'
420 n 2669^{3}
439

Johnson Matthey Pt

9'
8' like big D line

5.5' Band like not
n 0 807²d very bright.
Thin line
1045'. Thin lines
1° 59'
2° 3 Thin lines
42' L " "
48' Strong line nebulous
51' Thin

3° 16'.5 Wide band not very bright

40° 4' Thin band

40° 21'. Centre two lines

6° 42' Thin line

7° 22' Bright line near a great many other lines nearly as bright

~~7° 22' R~~

40' R

73 : 367 :: 18.5

185
1835
2936
367
73)67895(93
657
219

133

73

65 : 240 :: x : 1056

65)240(.37
195
450
455

56
.37
392
168
20.72.

142.5)524(364
4275
9650
8950
.7000

365

674
365
3370
4044
2022
60' | 246.010
Rd 3° 6'

.479
365
2395
2874
1437
60 | 176.835
2° 56'

365
29
3105
730
10405.

161

273
161
273
1638
273
14395.3

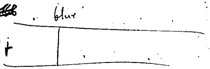
2° 35
120
155
273
465
1685
316
423.15

1000
709
291
365
1455
1566
873
104415

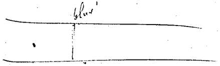
1° 40'

1502
365
7510
9012
4506
6 548230
9 8

45

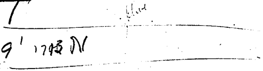


1° 39' Pt
99
3
102
1410

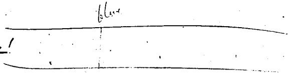


58' 7

~~2° 59'~~

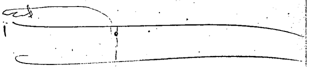


2° 59' 1713 N
120
179
182



5° 22'
322
3
325

~~10~~
3° 8'



3° 1'

3° 12'

206

4° 12

60
240
.12
252 5

16)65/68(.4

5.4
7.5
12.9

207

Prony

535 2.7283
11.75 1.0700
10.4 1.0170
~~0.9731~~

~~4.7714~~

~~59100~~ ft. lbs.
4.8183

#

65.800

7.00 Revo. machine

480
480
5280
129

3.7226
1.1106
4.8332

68.100.

$\frac{7.00}{1100}$ to

$\frac{5600}{1100}$ 5.1

6½ lbs

---

497 revs

6 lbs

11° 35' Dynamometer

200 on high resistance

495

6¼

200 H.R

11° 45'

Wt $CaSO_4$ 563 grms 14 grms

CO_3 530 grms 7

Accepting his figures

Engineering May 9, 1879 Dr Hopkinson's
Tests If 1.079 Volts = E.M.F 1 Daniells

$\frac{1.079}{1.125}$

.03302
.05115
$\bar{1}.98187$
2
$\bar{1}.96374$

then

.919 $\bar{1}.96374$
91.9% 1.96374

Assume total resistance of machine as 0.683 ohms as this is the normal temperature after running some time as 0.14 Ohm is the normal temperature of the Edison machine

log 0.683 = $\bar{1}.83442$
comp — 10.16558

Ex 4 4.07 Ohms Total
3.387 ~ outside
1.149 Eng^{10} Total work in current

1.179 Eng^{10} Dynamometer

$\frac{1.149 \times .919}{1.179} \times \frac{3.387}{4.07}$ per cent

4.07
.683
3.387

1.149 .06032
.919 $\bar{1}.96374$
comp 1.179 9.92849
.876% Total $\bar{1}.95255$
3.387 .52982
comp 4.07 9.39041
74.6% outside $\bar{1}.87278$
H.P. 1.68 .22531
1.25 0.09809

Ex 5   3.88 Ohms

1.285 Erg^{10} in current
1.263 Erg^{10} in belt
Which is impossible

3.88
.683
3.197 Ohms external

	1.285	0.10890
	91.9	1.96374
Comp	1.263	9.89860
	93.1%	1.96924
	3.197	0.50474
comp	3.88	9.41117
		1.88515
	76.7%	

Ex 6   3.205 Ohms Total
0.683
2.512

Erg^{10} 1.972 Total work in current
2.106 " " " belt
2.81 H.P.

	1.972	.29491
	91.9	1.96374
comp	2.106	9.67654
	86.1%	1.93519
	2.512	0.40002
comp	3.205	9.49417
		1.82938
	67.5%	

Ex 7 3.025 Ohms Total
0.683
2.342 ohms outside

2.174 Erg^{10} Total work in current
2.392 " ~ ~ - belt
3.19 H.P.

2.174	0.33726
91.9	1.96374
Comp 2.392	9.62124
83.6%	1.92224
2.342	0.36959
comp 3.025	9.51927
64.7%	1.81110

Ex 8 2.62 ohms total
.683
1.937 ohms outside

2.718 Erg^{10} ~~total~~ work in current
2.780 " - - - belt
3.71 H.P.

2.718	.43425
91.9	1.96374
comp 2.780	9.55595
89.9%	1.95394
1.937	0.28713
comp 2.62	9.58170
66.5%	1.82277

Ex 9   2.43 Ohms total
.683
1.747

2.894 Eng^{10} work in current
3.370 " — — belt

4.49 H.P.

2.894   0.46150
91.9   1.96374
comp 3.370   9.47237
79%   1.89761
1.747   0.24229
Comp 2.43   9.61439
56.8%   1.75429
4.49   6522
.4064

2.55

Ex 10   2.28 Ohms Total
.683
1.597 — outside

3.138 Eng^{10} Total work in current
3.538 " — " " belt

4.72 H.P.

3.138   0.49665
91.9   1.96374
comp 3.538   9.45124
81.6%   1.91163
1.597   0.20330
Comp 2.28   9.64207
1.75700
57.1%
4.72   .6739
.4309

2.7

Ex. 11

2.08 Ohms total
0.683
1.397 Ohms outside

3.671 Erg^{10} in current
3.960 Erg^{10} in belt
5.28 H.P.

3.671	0.56478
91.9	1.96374
comp 3.96	9.40230
	1.93082
85.3%	0.14520
1.397	
comp 2.08	9.68194
	1.75796
57.2% outside	.7226
	.4805

3.02 H.P. outside

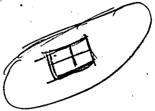
Ex 12

1.345
.683
.662

5.51 Erg^{10} total work in current
5.777 – – – – belt
7.7 H.P.

5.51	0.74115
comp 5.777	9.23830
95.4	9.97945
91.9	1.96374
87.7	1.94319
.662	$\bar{1}$.82086
comp 1.345	9.87128
	1.63533
43.1%	0.88649
	0.52182

3.32 H.P. delivered outside



2.894
3.138
3.671
5.510
4) 15.213
3.803 Erg^10

3.370
3.538
3.960
5 777
4) 16.645
4,161 Erg^10

3,803 .58013
4,161 .61.920
1.96093 91.5%
1.96374
.92467

58013
96374
.54387
61920
.92467

3.45 84%

4.49
4.72
5.28
7.70
4) 22.19
5.55 H. P. in belt

83.9) 907 (10
839
680

907
839
68) 907 (13.3
68
227
204
23

2.55
2.7
3.02
3.32
4) 11 59
2.89 H. P. outside

2.89 .4609
5.55 .7443
.7166

52%

137 mm

h = height Hg. in mm to compress

h' = distance from top tube

v = volume bulb & tube

v'' = [illegible] tube

V'' = [illegible] 1 mm tube

Bulb

1488
1525
1507
1132
5652
2088
3564
522
4
2088

3564 Grammes in bulb

$$32.7814 \; \dot{\bar{V}} = \frac{3564 \quad 5422}{3569422}$$

27.3585
5.4229

137) 5422.9 (39.57 = V''
411
1312
1233
799
685
1140

$760 \quad \frac{V}{V''} \quad \frac{1}{h^2}$

$39.57 \overline{)\,356942200}\,(90205 = \frac{V}{V'}$

35613

8122

7914

20800

90205

760

5412300

631435

$68555800 = 760 \frac{V}{V''}$

Formulae

H = height of Hg. in tube
h = distance from top tube
l = length tube
V = Weight Hg ~~in tube~~ and bulb
v = " " " tube
$\frac{v}{l}$ = " " " 1 mm
p = original pressure

$\frac{V}{v}\frac{760}{H}$ = millionths to entrance tube $= p$

$\frac{V}{\frac{v}{l}}\frac{760}{H}$ = millionths to 1 mm $= \frac{lV}{v}\frac{760}{H} = p$

$\frac{lV}{vh}\frac{760}{H}$ = millionths at h mm from top of tubes

$h = H.$

$$\frac{lV}{v}\frac{760}{H^2}$$

$$(V+v)p = (p+H)v$$

Francis gauge

l = 131 mm

V = 422478 mg.
v = 712 mg.

```
712)422478(593.3 = V/v
    3560
    6647
    6408
     2398
     2136
      2620
```

```
          593.3
            760
        355980
        41531
        450908.0
            131
        450908
      1352724
     450908
     59068946
```

$760\frac{V}{v} =$ 450908.0

$\frac{lV}{v}760 =$ 59068946

Gauge up stairs

$l = 137$ mm

$V = 3569422$ mg.

$v = 5423$ mg.

$5423) 3569422 (658 = \frac{V}{v}$

32538

31562

27115

44470

43384

658

760

40480

4606

$760 \frac{V}{v}$

501080

137

3507560

150324

50108

68647.600

Small guage 59.000,000

large " 68.600 000

Small guage .43

large .32

Capillarity in small gauge.

10 mm

18 mm from the end

in the small gauge would

represent a millionth

Lamp holds 4 lbs 10 oz

$4.500
5
$22.500
.03
675.00

250 H.P.

.171
.136
35000
3500

6425
4825
1600
3500
5.100
2,500
7.600 $

22500
02
45000

6 | 1250.
416
1666

(86000
28666
114666
50000
$ 164666
(3835
1278
5113
1000
6113

Boilers & Chimney	21000
Engines	22.500
Foundation. —	
Structure —	7.000
Shafts &c —	
Belts —	
Wood flooring &c —	
Water heater & pumps	7.000
Iron floor & Boiler supports	6.000
Faradic Machines	22.500
Conductors	50.000
	$ 136.000
	50
	86000

In place $171,400
50
2,400.00

Depreciation

Boilers & Chimney	10%	2,100
Engines	3%	675
Structure	2%	140
Water heater & pumps	5%	350
Boiler floor	2%	120
Faradic Machines	2%	450
Conductors	2%	1000
		4835

6 per H. P.

1250 H. P.
6

Labor.

$33 per day

Coal $29.30 per day

Rent &c $7500 per year

Investment $164,666

Depreciation $6113

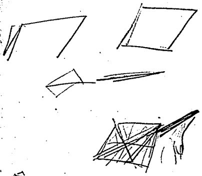
Sophia

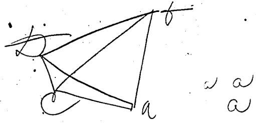
Sophia Rutter

Miss Sh

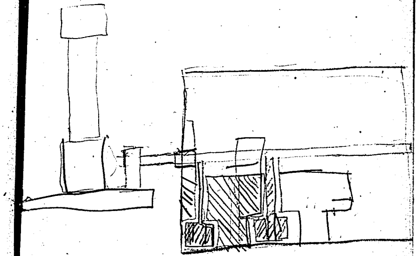
Miss Sophia Latem
Hotel Brun
N. Y.

Miss




b
a
a a
a

[illegible]



$\frac{12}{13}$ $\frac{12}{13}$

$$W = C\mathcal{E} = C(\mathcal{E}' + \mathcal{E}'')$$

$$\mathcal{E}' = CR$$

$\mathcal{E}''$ = Contrary E.M.F. Motor

$$W' = C^2R = \mathcal{E}'C = \frac{\mathcal{E}'^2}{R}$$

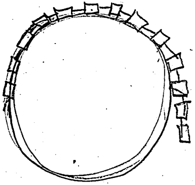
$$W'' = W - W' = C\mathcal{E} - \frac{\mathcal{E}'^2}{R}$$

10 H.P.

2.5 H.P.

3/4 47%

$$\begin{array}{r} 83 \\ 83 \\ \hline 249 \end{array}$$



$\mathcal{E}' = C R$

r = resistance machine

Condition Work outside = W_0

W_0 ~~W~~ $= 12\,C^2 r$

$\mathcal{W}_0 = 12 C^2 r$

$\mathcal{W}_0 = C(\mathcal{E}' + \mathcal{E}'') - C^2 r$

$= C\mathcal{E}'' + C^2(R - r) = 12 C^2 r$

$C = \frac{\mathcal{E} - \mathcal{E}''}{R}$ $\quad {}_0\mathcal{W}$

$\mathcal{E}'' + C(R - r) = 12 C r$

$\mathcal{E}'' = 13 C r - C R$ $\quad$ [illegible]

$= C(13 r - R)$

$13 r = R$ $\quad \mathcal{E}'' = 0$

$5 r = R \qquad r = \frac{R}{5}$

$\mathcal{E}'' = C\left(\frac{13 R}{5} - R\right)$

$= \frac{8 C R}{5} \qquad C R = \mathcal{E}'$

$\mathcal{E}'' = \frac{8}{5}\mathcal{E}' \qquad \mathcal{E}' + \mathcal{E}'' = \mathcal{E}$

$\therefore \mathcal{E}' = \mathcal{E} - \mathcal{E}''$

$\mathcal{E}'' = \frac{8}{5}\mathcal{E} - \frac{8}{5}\mathcal{E}''$

$\mathcal{E}'' + \frac{8}{5}\mathcal{E}'' = \frac{8}{5}\mathcal{E}$

$13\mathcal{E}'' = 8\mathcal{E}$

$\mathcal{E}'' = \frac{8}{13}\mathcal{E}$

$\mathcal{W}_0$

Let it be assumed that $\frac{n}{m}$ of the total work can be recovered outside

If there is no contrary E.M.F.

r = resistance Machine

R = Total outside resn

$R : r :: \frac{n}{m} : \frac{m-n}{m}$

$R = \frac{n}{(m-n)} r$

If contrary E.M.F. = $\mathcal{E}''$

Current = C $\mathcal{E}' = \mathcal{E} - \mathcal{E}''$

W = work outside

w = " inside

$W = \frac{n}{(m-n)} w$

$w = C^2 r$

$W = \frac{n}{m-n} C^2 r$ (1)

$W = C(\mathcal{E}'' + \mathcal{E}') - C^2 r$

$C\mathcal{E}' = C^2 (R + r)$

$W = C\mathcal{E}'' + C^2(R + r) - C^2 r$

$= C\mathcal{E}'' + C^2 R$ (2) & (1)

$\frac{n}{m-n} C^2 r = C\mathcal{E}'' + C^2 R$

$\frac{n}{m-n} C r = \mathcal{E}'' + C R$

~~$\mathcal{E}'' = \frac{n}{m-n} C(r$~~

$\mathcal{E}'' = C\left(\frac{n}{m-n} r - R\right)$

$R = l r$ $R + r = (l + 1) r$

$\mathcal{E}'' = C\left(\frac{n}{m-n} r - l r\right)$

$= C r\left(\frac{n}{m-n} - l\right) = C r\left(\frac{n - l(m-n)}{m-n}\right)$

$= C r\left(\frac{n - lm + ln}{m-n}\right)$

$= C r\left(\frac{n(1+l) - lm}{m-n}\right)$

$$c = \frac{\varepsilon'}{R+r} = \frac{\varepsilon'}{lr+r} = \frac{\varepsilon'}{r(l+1)}$$

$$\varepsilon'' = cr\left(\frac{n(1+l)-lm}{m-n}\right)$$

$$= \frac{\varepsilon' r}{r(l+1)}\left(\frac{n(1+l)-lm}{m-n}\right)$$

$$= \frac{\varepsilon'}{l+1}\left(\frac{n(1+l)-lm}{m-n}\right)$$

$n = 12$
$m = 13$
$l = 5$

$$\varepsilon'' = \frac{\varepsilon'}{6}\left(\frac{12(6)-5\times13}{13-12}\right)$$

$$= \frac{\varepsilon'}{6}(72-65)$$

$$= \frac{\varepsilon' 7}{6} = \frac{7}{6}\varepsilon$$

$l = 4$

$$\varepsilon'' = \frac{\varepsilon'}{5}\left(\frac{12\times5-4\times13}{13-12}\right)$$

$$= \frac{\varepsilon'}{5}\left(\frac{60-52}{1}\right)$$

$$= \frac{8}{5}\varepsilon'$$

Estimate Transmission

Three machines 600 Volts
To transmit

Two machines 400 Volts
receivers

200 Volts active

Resistance line 2 Ohms
" Transmitters 1.68
" " 1.12
4.80

$$\begin{array}{r} 14 \\ \hline .56 \\ 3 \\ \hline 1.68 \end{array} \qquad \begin{array}{r} .56 \\ 2 \\ \hline 1.12 \end{array}$$

200 2.3010
200 2.3010
1.6464
4.8 9.3188
5.5672
369000 4.5185
.0487

11.4 H.P.

$$\mathcal{E}'' = \frac{\mathcal{E}'}{l+1}\left(\frac{n}{m-n} - l\right) = g\,\mathcal{E}'$$

$$\mathcal{E}'' = \mathcal{E} - \mathcal{E}' \qquad \mathcal{E}' = \mathcal{E} - \mathcal{E}''$$

$$\mathcal{E}'' = g(\mathcal{E} - \mathcal{E}'')$$

$$\mathcal{E}'' + g\,\mathcal{E}'' = g\,\mathcal{E}$$

$$\mathcal{E}'' = \frac{g}{1+g}\,\mathcal{E}$$

$$= \frac{\frac{1}{l+1}\left(\frac{n}{m-n} - l\right)}{1 + \frac{1}{l+1}\left(\frac{n}{m-n} - l\right)}\,\mathcal{E}\,.$$

$$= \frac{\frac{nl+n}{m-n} - l^2 - l}{l+1+1+\left(\frac{nl+n}{m-n} - l^2 - l\right)}$$

$$= \frac{nl+n-l^2m-lm+nl^2+ln}{\cancel{n}l-2n+\cancel{n}l+n-l^2m-\cancel{lm}+l^2n+\cancel{ln}}$$

$$= 2nl+n-l^2m-$$

Let $n = 12$ $\qquad \dfrac{\mathcal{E}''}{\mathcal{E}'} = \dfrac{11}{2}$

$m = 13$

$l = 1$

$$\mathcal{E}'' = \frac{\mathcal{E}'}{2}(12-1) \qquad \mathcal{E}' = \frac{2}{13}\mathcal{E}$$

$$= \frac{11}{2}\mathcal{E}' = \frac{\frac{11}{2}}{\frac{11}{2}+1}\mathcal{E} = \frac{11}{13}\mathcal{E}$$

$l = 2$

$$\mathcal{E}'' = \frac{\mathcal{E}'}{3}(12-2) = \frac{10}{3}\mathcal{E}'$$

$$\mathcal{E}'' = \frac{10}{13}\mathcal{E} \qquad \mathcal{E}' = \frac{3}{13}\mathcal{E}$$

$$\frac{\mathcal{E}''}{\mathcal{E}'} = \frac{9}{4}$$

$l = 3$

$$\mathcal{E}'' = \frac{9}{13}\mathcal{E} \qquad \mathcal{E}' = \frac{4}{13}\mathcal{E}$$

$$\frac{\mathcal{E}''}{\mathcal{E}'} = \frac{8}{5}$$

$l = 4$

$$\mathcal{E}'' = \frac{8}{13}\mathcal{E} \qquad \mathcal{E}' = \frac{5}{13}\mathcal{E}$$

$$\frac{\mathcal{E}''}{\mathcal{E}'} = \frac{7}{6}$$

$l = 5$

$$\mathcal{E}'' = \frac{7}{13}\mathcal{E} \qquad \mathcal{E}' = \frac{6}{13}\mathcal{E}$$

$$W = C\varepsilon'' + C\varepsilon' - c^2 r$$

$$W = C\varepsilon - c^2 r$$

$$W = \frac{n}{m-n} c^2 r$$

$$C = \frac{\varepsilon'}{R+r}$$

$$W = \frac{n}{m-n}\left(\frac{\varepsilon'}{R+r}\right)^2 r$$

$$W = \frac{n}{m-n} c^2 r$$

$$W = C\varepsilon - c^2 r$$

$$W = C\varepsilon'' + C\varepsilon' - c^2 r$$

$$\varepsilon'' = 0$$

$$W = C\varepsilon' - c^2 r = C\varepsilon$$

$$= \frac{\varepsilon^2}{R+r}$$

$$\varepsilon' = \varepsilon - \varepsilon''$$

ε is constant

ε'' ~~varies~~ $f(l)$

ε'' $f(l)$

m & n = constants.

$$C = \frac{\varepsilon - \varepsilon''}{R+r}$$

$$\varepsilon'' = \frac{g}{1+g}\varepsilon$$

$$C = \frac{\varepsilon - \frac{g}{1+g}\varepsilon}{R+r}$$

$$= \frac{\varepsilon\left(\frac{1+g-g}{1+g}\right) \cancel{\varepsilon}}{R+r}$$

$$= \frac{\frac{1}{1+g}\varepsilon}{R+r}$$

$W = c\mathcal{E} - c^2 r$

$= \frac{\frac{1}{1+g}\mathcal{E}^2}{R+r} - \left(\frac{\frac{1}{1+g}}{R+r}\mathcal{E}\right)^2 r$

$= \frac{\mathcal{E}^2}{R+r}\left(\frac{1}{1+g} - \frac{\left(\frac{1}{1+g}\right)^2}{R+r} r\right)$

$R = \ell r$

$= \frac{\mathcal{E}^2}{R+r}\left(\frac{1}{1+g} - \frac{\left(\frac{1}{1+g}\right)^2}{(\ell+1)r}\cancel{r}\right)$

$= \frac{\mathcal{E}^2}{R+r}\left(\frac{1}{1+g} - \frac{\left(\frac{1}{1+g}\right)^2}{\ell+1}\right)$

$= \frac{\mathcal{E}^2}{R+r}\left(\frac{1}{1+g}\left(\frac{1-\frac{1}{1+g}}{\ell+1}\right)\right)$

$= \frac{\mathcal{E}^2}{R+r}\left(\frac{1}{1+g}\left(\frac{\frac{1+g-1}{1+g}}{\ell+1}\right)\right)$

$= \frac{\mathcal{E}^2}{R+r}\left(\frac{1}{1+g}\left(\frac{\frac{g}{1+g}}{\ell+1}\right)\right)$

$= \frac{\mathcal{E}^2}{R+r}\left(\frac{g}{(1+g)^2(\ell+1)}\right)$

$\mathcal{E}'' = 0$

$= \frac{\mathcal{E}^2}{R+r}$

$\frac{n}{m-n} = \ell$

$n = 12$

$m = 13$

$\ell = 1$

$g = \left(\frac{n}{m-n} - \ell\right) = 12 - 1 = 11$

$= \frac{\mathcal{E}^2}{R+r}\left(\frac{11}{(1+11)^2(\ell+1)}\right)$

$= (\ )\ \frac{11}{144 \times 2} = (\ )\ \frac{11}{288}$

$\mathcal{E}'' = \frac{11}{13}\mathcal{E}$ $\quad \mathcal{E}' = \frac{2}{13}\mathcal{E}$

$\frac{\mathcal{E}''}{\mathcal{E}'} = \frac{11}{2}$

~~Work [illegible]~~ ~~39~~

~~$\left(\frac{2}{13}\right)^2 = \frac{4}{169}\frac{\mathcal{E}^2}{R+r}$~~

~~$\frac{44}{338} + \frac{8}{338} = \frac{52}{338} = \frac{26}{169}$~~ $= \frac{2}{13}$

$$W = \frac{\mathcal{E}^2}{R+r}\left(\frac{1}{1+g} - \frac{\left(\frac{1}{1+g}\right)^2}{l+1}\right)$$

$$= (\,)\left(\frac{1}{1+g}\left(\frac{l+1-\frac{1}{1+g}}{l+1}\right)\right)$$

$$= (\,)\left(\frac{1}{1+g}\left(\frac{l+\frac{g}{1+g}}{l+1}\right)\right)$$

$g = 11 \quad l = 1$

$$= (\,)\frac{1}{12}\left(\frac{1+\frac{11}{12}}{2}\right)$$

$$= (\,)\frac{1}{12}\left(\frac{\frac{23}{12}}{2}\right)$$

$$= (\,)\frac{23}{288}$$

$\begin{array}{r}16\\13\\\hline 48\\16\\\hline 208\end{array}$

$\frac{2}{13}$

[illegible] [illegible]

$\mathcal{E}''$ [illegible] $\frac{4}{169}$

$\frac{23}{288}$

.100

443,000

2

33) 886 000 = 26 H.P.

66

226

200 Volts 100 H.P.

300

225

10 lbs to ton

52,800 600

Treatise on manufacture of Paper

$n = 3$

$m = 4 \qquad l = 1$

$g = \left(\frac{n}{m-n} - l\right) = 3 - 1 = 2$

$g = 2$

$\varepsilon'' = \frac{g}{1+g}\,\varepsilon = \frac{2}{3}\,\varepsilon$

$\varepsilon' = \frac{1}{3}\,\varepsilon \qquad \frac{\varepsilon''}{\varepsilon'} = 2$

$$W = l\,)\left(\frac{1}{1+g}\;\frac{l + \frac{g}{1+g}}{l+1}\right)$$

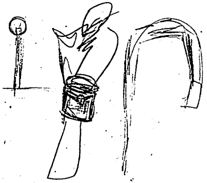
$$= (\,)\left(\frac{1}{3}\;\frac{1 + \frac{2}{3}}{2}\right)$$

$$= (\,)\left(\frac{1}{3} \times \frac{5}{6}\right) = (\,)\,\frac{5}{18} \rightarrow$$ [illegible]

$\frac{1}{9}\,\varepsilon$

$\frac{1}{9} + \frac{2}{9} = \frac{3}{9} = \frac{1}{3}$

$\frac{1}{3} - \frac{1}{4}\,\frac{1}{3} = \frac{4}{12} - \frac{1}{12} = \frac{3}{12} = \frac{1}{4}$



$C = \frac{\mathcal{E}'}{R+r}$

$\mathcal{E}' = C\,R+R$

$\mathcal{E} = \mathcal{E}' + \mathcal{E}''$

$= C(R+r) + \mathcal{E}''$

Let r = resistance machine

R = outside resistance

$\mathcal{E}$ = E.M.F transmitter constant

$\mathcal{E}''$ = — — Motor variable

$\mathcal{E}' = \mathcal{E} - \mathcal{E}''$ = E.M.F active

W = work outside

w = work inside.

C = Current

$n = \frac{W}{w}$ constant

$l = \frac{R}{r}$ variable

$\mathcal{E} = C(R+r) + \mathcal{E}''$

$W = C(\mathcal{E}'+\mathcal{E}'') - C^2 r$

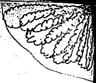
$\cancel{W}\ W = nw = nC^2 r$

$nC^2 r = C(\mathcal{E}'+\mathcal{E}'') - C^2 r$

$nCr = \cancel{C}(\mathcal{E}'+\mathcal{E}'') - Cr$

$C(nr+r) = \mathcal{E}'+\mathcal{E}''$

$C =$



$$\mathcal{E} = \mathcal{E}' + \mathcal{E}''$$

$$c(\mathcal{E}' + \mathcal{E}'') = W + w$$

$$c = \frac{\mathcal{E}'}{R + r}$$

$$w = c^2 r$$

$$c(\mathcal{E}' + \mathcal{E}'') = W + c^2 r$$

$$c(\mathcal{E}' + \mathcal{E}'') - c^2 r = W$$

$$\frac{\mathcal{E}'}{R+r}(\mathcal{E}' + \mathcal{E}'') - \left(\frac{\mathcal{E}'}{R+r}\right)^2 r = W$$

$$l = \frac{R}{r} \qquad R = lr$$

$$\frac{\mathcal{E}'}{(l+1)r}(\mathcal{E}' + \mathcal{E}'') - \left(\frac{\mathcal{E}'}{(l+1)}\right)^2 \frac{1}{r} = W$$

$$W = nc^2 r$$

$$= n\left(\frac{\mathcal{E}'}{R+r}\right)^2 r$$

$$= \frac{n\mathcal{E}'^2}{(1+l)^2 r}$$

$$= \frac{\mathcal{E}'}{(1+l)r}(\mathcal{E}' + \mathcal{E}'') - \left(\frac{\mathcal{E}'}{1+l}\right)^2 \frac{1}{r} -$$

$$n\mathcal{E}'^2 = (1+l)\mathcal{E}'(\mathcal{E}' + \mathcal{E}'') - \mathcal{E}'^2$$

$$n\mathcal{E}' = (1+l)(\mathcal{E}' + \mathcal{E}'') - \mathcal{E}'$$

$$(1+n)\mathcal{E}' = (1+l)(\mathcal{E}' + \mathcal{E}'')$$

$$(1+n-1-l)\mathcal{E}' = (1+l)\mathcal{E}''$$

$$\mathcal{E}' = \frac{1+l}{n-l}\mathcal{E}'' =$$

$$n = 12$$

$$l = 1 \qquad\qquad \mathcal{E}' = \mathcal{E} - \mathcal{E}''$$

$$\mathcal{E}' = \frac{2}{11}\mathcal{E}'' \qquad \frac{2}{11}\mathcal{E}'' = \mathcal{E} - \mathcal{E}''$$

$$\mathcal{E}'' = \frac{11}{13}\mathcal{E} \qquad \frac{13}{11}\mathcal{E}'' = \mathcal{E}$$

$$\mathcal{E}' = \frac{1+l}{n} \qquad \mathcal{E}' = \frac{2}{13}\mathcal{E}$$

$$\varepsilon' = \frac{1+l}{n-l}\,\varepsilon'' = h\,\varepsilon$$

$$\varepsilon'' = \varepsilon - \varepsilon'$$

$$\varepsilon' = h\,\varepsilon - h\,\varepsilon'$$

$$\varepsilon' + h\,\varepsilon' = h\,\varepsilon$$

$$\varepsilon' = \frac{h\,\varepsilon}{1+h}$$

$$\frac{\frac{1+l}{n-l}}{1+\frac{1+l}{n-l}} = \frac{\frac{1+l}{n-l}}{\frac{n-l+1+l}{n-l}}$$

$$= \frac{1+l}{n+1} = \frac{1+l}{1+n}\ c$$

$$\varepsilon' = \frac{1+l}{1+n}\,\varepsilon = g\,\varepsilon$$

$n = 12 \quad l = 1$

$$\varepsilon' = \frac{12}{13}$$

$$\varepsilon'' =$$

$$\varepsilon'' = \left(1 - \frac{1+l}{1+n}\right)\varepsilon$$

$$= \left(\frac{1+n-1-l}{1+n}\right)\varepsilon$$

$$= \frac{n-l}{1+n}\,\varepsilon$$

$$\varepsilon'' = \frac{11}{13}$$

$$W = n\,w = n\,C^2 r.$$

$$W = C\,\varepsilon - n\,C^2 r.$$

$$C = \frac{\varepsilon'}{R+r} = \frac{\frac{1+l}{1+n}\,\varepsilon}{R+r}$$

ε' $\qquad R+r = ln+r = (1+l)r$

$$C = \frac{1}{(1+n)r}\,\varepsilon$$

$$W = \frac{1}{(1+n)r}\,\varepsilon^2 - n\left(\frac{1}{(1+n)r}\,\varepsilon\right)^2 r$$

$$= \frac{\varepsilon^2}{(1+n)r}\left(1 - \frac{n}{1+n}\right)$$

$$= \frac{\mathcal{E}^2}{(1+n)r}\left(\frac{1}{1+n}\right)$$

$$= \frac{\mathcal{E}^2}{r}\left(\frac{1}{1+n}\right)^2$$

$$\frac{\mathcal{E}^2}{} \qquad \mathcal{E}'' = 0$$

$$n = \ell$$

$$W = n\,\mathcal{E}^2 r \qquad \frac{\mathcal{E}^2}{R+r}$$

$$\frac{\mathcal{E}^2}{} \qquad \frac{\mathcal{E}^2}{R}$$

$$c = \frac{g\,\mathcal{E}}{R+r}$$

$$W = \frac{g\,\mathcal{E}^2}{R+r} - n\,\frac{g^2\mathcal{E}^2}{(R+r)^2}\,r$$

$$= \frac{g\,\mathcal{E}^2}{R+r}\left(1 - \frac{n\,g\,r}{(R+r)^2}\right)$$

$$= \frac{g\,\mathcal{E}^2}{R+r}\left(1 - \frac{n\,g\,r}{(R+r)^2}\right)$$

$$= \frac{g\,\mathcal{E}^2}{R+r}\left(1 - \frac{n\,g\,R}{(1+\ell)\,r}\right)$$

$$= \frac{g\,\mathcal{E}^2}{R+r}\left(1 - \frac{n\,g}{(1+\ell)\,r}\right)$$

$$\boxed{g = 1}$$

~~$\frac{r^2}{R}$ $\mathcal{E}^2$ $\frac{1}{R}$~~ [illegible]

$$c = \frac{g\,\mathcal{E}}{R+r} = \qquad g \quad \frac{\mathcal{E}}{R+r}$$

$$c = \frac{g\,\mathcal{E}}{R+r}$$

$W = nw = nc^2r$

$\left(\frac{\mathcal{E}^2}{R+r}\right)$ dependent on l

$g = \frac{1+l}{1+n}$

$C = \frac{\mathcal{E}'}{R+r} = \frac{g\mathcal{E}}{R+r}$

$W = n\frac{g^2\mathcal{E}^2}{(R+r)^2}r$

$= \frac{\mathcal{E}^2}{R+r}\frac{ng^2}{R+r}r$

$= \frac{\mathcal{E}^2}{R+r} \cdot \frac{n\left(\frac{1+l}{1+n}\right)^2}{(1+l)\cancel{r}}\cancel{r}$

$W = \frac{\mathcal{E}^2}{R+r} n \frac{1+l}{(1+n)^2}$

$n = l$

$w = \frac{\mathcal{E}^2}{R+r}\frac{n}{1+n}$ O. K

$n = 12$

$l = 1$

$W = \frac{\mathcal{E}^2}{R+r} 12 \frac{2}{13^2}$

$= \frac{\mathcal{E}^2}{R+r}\frac{24}{169}$

$\left(\frac{2}{13}\right)^2 = \frac{4}{169}$

$\frac{11}{2} \times \frac{4}{169} = \frac{22}{169}) + \frac{2}{169} = \frac{24}{169}$

$W = (\ ) \frac{n(1+l)}{(1+n)^2}$

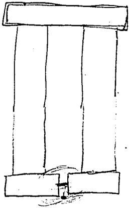
$W = (\ ) \frac{n(1+l)}{(1+n)^2}$

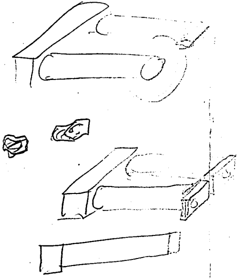
[redacted]

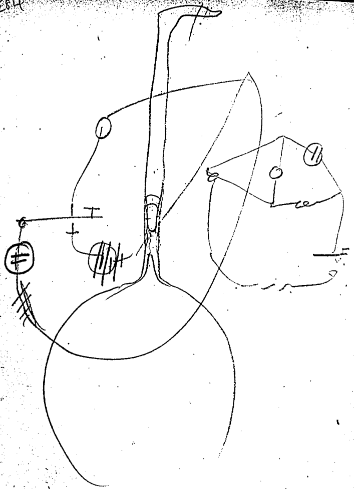
The = The Numbe

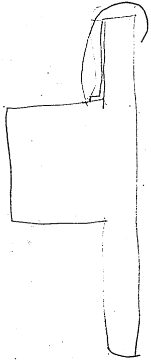
Friday Friday

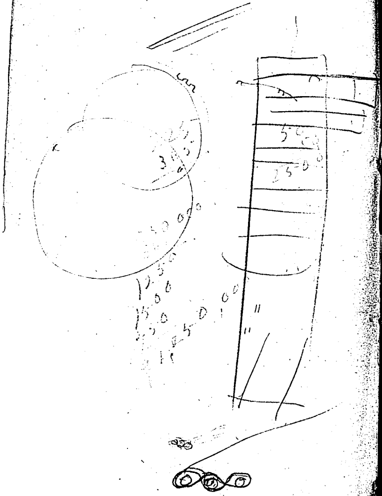
Friday fran










345
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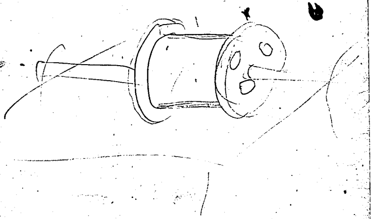
Do you want
any help to put
on the box
on Express train

6/2, Kreiser